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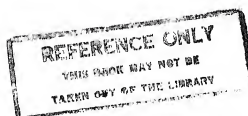
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Health and Safety
Commission

**Consultative
Document**

**Design and construction of road
tankers used to convey flammable
liquids**

Draft Approved Codes of Practice



Health and Safety Executive

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INTRODUCTION

1. The Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 (SI No. 1059) (the "Tanker Regulations") were laid before Parliament on 18 August, 1981, and came into operation, with certain exceptions, on 1 January, 1982.

2. At the time the Tanker Regulations were made, the Health and Safety Commission indicated that various codes of practice would be approved under Section 16 (1) of the Health and Safety at Work etc. Act 1974 in order to give practical guidance on the Regulations. To this end, two codes of practice have been approved so far:-

COP5 Classification of Dangerous Substances for Conveyance in Road Tankers and Tank Containers.

COP11 Operational Provisions of the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981.

3. A further topic for which the Commission indicated a code of practice would be approved was the design and construction of road tankers and tank containers. Regulation 6 of the Tanker Regulations gives general requirements for design and construction, and Schedule 2 to the Regulations lays down specific requirements for the design and construction of road tankers used for the conveyance of petroleum spirit and carbon disulphide.

4. This consultative document contains the first two draft Approved Codes of Practice which give practical guidance on Regulation 6. These respectively deal with vented, non-pressure flammable liquid tankers (mainly used for the conveyance of petrol) and carbon disulphide tankers. Other

codes of practice on design and construction are to be prepared, and are likely to include the following types of road tanker and tank container.

1. General chemical tankers.
2. Waste disposal tankers.
3. Liquefied gas tankers (other than vacuum insulated tankers).
4. Vacuum insulated gas tankers.
5. Tube trailers.
6. Tank containers.

5. It is proposed that these codes of practice will apply to new construction of road tankers subsequent to the date of coming into force of the codes. The date of coming into force will have to be linked to the date of revocation of Schedule 2, and amending regulations are currently being drafted which will incorporate this revocation. It is not intended that existing tankers should necessarily be brought up to the standard in these codes, and the draft Approved Code of Practice on the examination, testing and certification of tanks (for which a consultative document was published in February, 1984) indicates that existing tankers should be examined, tested and certified against the codes/specifications to which they were originally designed and constructed.

6. The two draft Approved Codes of Practice contain provisions relating to cab heaters which run independently of the engine of the vehicle. There is a certain voice of opinion which says that such heaters should not be allowed

in the cabs of vented, non-pressure tankers, although the concern does not extend to pressure tankers used for flammable liquids, of which carbon disulphide tankers are one type. It should be noted, however, that petrol tankers are not, and will not be, fitted with these heaters, and this concern only relates to a limited number of tankers.

7 These heaters are normally fitted and used when the cab is fitted with sleeping facilities. The operation of such a heater is more economical and less noisy than the operation of the heater run from the engine. The concern regarding vented, non-pressure tankers is because they are vented and, being thinner, are more prone to leak on impact. There is thus a greater chance of flammable vapour being present, compared with pressure tankers, in a situation where the heater is in use.

8. The Health and Safety Commission would, therefore, welcome comments on whether these independent cab heaters should be allowed in vented, non-pressure tankers used for the conveyance of flammable liquids. Assuming that such heaters are to be allowed, the Commission would also welcome comments on the conditions laid down for such heaters, especially as to whether they go far enough. These conditions are based on conditions laid down by the Federal Republic of Germany for the use of such heaters.

APPROVED CODE OF PRACTICE

Design and construction of vented, non-pressure road
tankers used to convey flammable liquids

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PREFACE

This Code of Practice has been prepared by the Institute of Petroleum in conjunction with the Health and Safety Executive. There has been joint discussion between representatives of the Confederation of British Industry, the Trades Union Congress, the Local Authorities, independent experts and the Health and Safety Executive on the contents of the Code under the auspices of the Health and Safety Commission's Advisory Committee on Dangerous Substances.

The Code has been approved by the Health and Safety Commission with the consent of the Secretary of State for Transport, under Section 16(1) of the Health and Safety at Work etc. Act 1974 (the "HSW Act") for the purposes of providing practical guidance with respect to the provisions of Regulation 6(1) of the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 (the "Tanker Regulations") (SI 1981 No. 1059). Any reference in this Code to another document does not imply approval of that document by the Health and Safety Commission under Section 16(1) of the HSW Act except to the extent necessary to give practical effect to this Code.

Although failure to comply with any provision of this Code is not in itself an offence, that failure may be used in criminal proceedings as evidence that a person has contravened the regulation to which the provision relates. In such a case, however, it will be open to that person to satisfy the court that he has complied with the regulation in some other way.

Words and expressions which are defined in the HSW Act and the Tanker Regulations have the same meaning in this Code unless the context requires otherwise.

Coincident with the coming into force of this Code, Regulation 6(2) and Schedule 2 of the Tanker Regulations are revoked by the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) (Amendment) Regulations 198 . The guidance given in this Code now replaces the specific requirements for the design and construction of road tankers used for the conveyance of petroleum spirit which were detailed in Part I of Schedule 2 to the Tanker Regulations.

This Code applies to vented, non-pressure tanks used for the conveyance of flammable liquids other than carbon disulphide. These are carrying tanks of road tankers in which the flammable liquid is effectively conveyed at atmospheric pressure and are loaded or discharged only by gravity or by pump. Such tanks are not 'pressure vessels' as defined by Regulation 7 of the above regulations. This does not mean, however, that flammable liquids may not be conveyed in pressure tanks.

Flammable liquids are defined in Schedule 1 of the Tanker Regulations and in paragraph A7 of the Approved Code of Practice 'Classification of dangerous substances for conveyance in road tankers and tank containers' (COP5).

This Code lays down minimum standards and does not take account of any special circumstances such as the use of vehicles over rough terrain. Such factors would have to be taken into account in deciding whether vehicles or tanks comply with the requirements of Regulation 6(1).

Unless the context requires otherwise, wherever "fittings" are referred to in the Code they should be interpreted as those items which are in contact with the product being conveyed or are used for filling, discharging or pressure relief of the tank, and which, if damaged, would be likely to cause a leakage of the product.

The Code is intended to provide practical guidance on the design and construction of road tankers and applies only to rigid vehicles, tractors or semi-trailers constructed after the date of coming into force of the Code. It does not apply to tank containers nor does it cover the inspection and testing of the carrying tank and its fittings which normally takes place during or immediately following construction. The requirements for such inspection and testing are provided in Regulation 7 and practical guidance is given in the Approved Code of Practice on the Examination, Testing and Certification of the Carrying Tanks of Road Tankers and of Tank Containers used for the Conveyance of Dangerous Substances (COP ?).

The duty to comply with Regulation 6(1) is placed upon the operators of road tankers. "Operator" is defined in Regulation 5. The main purpose of this Code is to provide standards which an operator can present to a manufacturer when he wishes to order a new vehicle or carrying tank for a road tanker.

The standards laid down in the Code are minimum standards which an operator would have to relate to the intended purpose of the vehicle and tanks he was ordering. This code is not a detailed design code for manufacturers. Section 6 of the HSW Act lays a separate duty on any person who designs, manufactures, imports or supplies any article for use at work to ensure, so far as is reasonably practicable, that the article is so designed and constructed as to be safe and without risks to health when properly used.

The requirements for vehicles and tanks conveying dangerous substances laid down in the Tanker Regulations and this Code are in addition to any requirements imposed by the Road Traffic Act 1972 and associated legislation. Particular attention should be paid to the requirements of the Motor Vehicles (Construction and Use) Regulations 1978 and amendments thereto.

Other guidance on the requirements of the Regulations and on the provision of safe means of access to tank tops is contained in the following documents:-

Approved Code of Practice on the Classification of Dangerous Substances for Conveyance in Road Tankers and Tank Containers (COP 5).

Approved Code of Practice on the Operational Provisions of the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 (COP 11).

Guide to the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981. Health and Safety Series Booklet HS(R)13.

Access to Road Tankers. Health and Safety Executive Guidance Note GS 26.

REGULATION 6(1)

For ease of reference, Regulation 6(1) is reproduced below.

1 An operator shall not use any vehicle or any tank container for the conveyance by road of a dangerous substance unless -

- (a) it is properly designed, of adequate strength and of good construction from sound and suitable material;
- (b) it is suitable for the purpose for which it is being used having regard to -
 - (i) the nature and circumstances of the journey being undertaken; and
 - (ii) the characteristic properties and quantity of the dangerous substance and of all other substances being conveyed (including any which are not in themselves dangerous);
- (c) the carrying tank of the road tanker or, as the case may be, the tank container and any fittings attached thereto -
 - (i) are designed, constructed and maintained so as to prevent any of the contents escaping, except that this requirements shall not prevent the fitting of a suitable safety device; and
 - (ii) in so far as they are likely to come into contact with the substance, are made of materials which are neither liable to be adversely affected by the substance nor liable in conjunction with it to form any other dangerous substance which would significantly increase the risk to the health and safety of any person.

The Engine

1 For liquids with a flash point of less than 21°C the engine should be of the compression ignition type and an external accessible means should be provided to stop the engine in an emergency. This engine stop should be indicated by a clearly visible notice.

Air Induction System

2 The air induction system should be located in such a position as to minimise the possibility of induction of flammable vapour from any spillage of flammable liquid or from any release from a safety relief device.

Exhaust System

3 The exhaust system, including any turbo charger, should be located in such a position or be so shielded that any spillage or leakage of flammable liquid being conveyed cannot impinge on the heated surface of the system. A vertical exhaust may be used provided there is an effective method of preventing ingress of a flammable liquid.

Fuel System

4 The fuel tank should not be located directly above the engine or its exhaust system.

Electrical System

5 The electrical system should be designed, installed and adequately protected to minimise mechanical damage and the risk of electrical fires. In particular the system should conform to the following requirements.

- (a) The nominal circuit voltage of any circuit on the vehicle should not exceed 24 volts.
- (b) Where it is not possible to energise apparatus on the vehicle at 24 volts and it is fed from an external supply, the wiring and apparatus should be separated from the vehicle's own electrics and should comply with the requirements for the zone of use as detailed in BS 5345: 1976 and have the chassis bonded to the protective conductor of the external supply.
- (c) Modifications or repairs to electrical circuits or equipment on vehicles should be in accordance with manufacturer's instructions or be to recognised manufacturer's or equivalent standards.
- (d) Behind the rear of the driver's cab all cables should have copper conductors (except for the heavy duty cable from the battery to the starter motor which may be in aluminium provided compression terminations are used), and should be insulated and further covered in accordance with the requirements of BS 6862: 1971. They should be conservatively rated to avoid undue temperature rise in service.

(e) Batteries should be effectively protected against spillage of flammable liquid, and be fitted with an insulated cover against inadvertant contact by objects which could cause a spark.

(f) All cables should be located and secured on the vehicle so that they are protected against mechanical damage and heat.

6. Where flammable liquids with a flash point of less than 21°C are conveyed, the following additional electrical requirements should be complied with.

(a) Behind the rear of the driver's cab -

(i) no screw-in or capless bulbs should be used;

(ii) junction boxes, connectors and all electrical equipment should be adequately protected and shielded as far as practicable from the ingress of moisture or dangerous substances under normal conditions of use;

(iii) switches should be suitable for use in Zone 2 areas as defined in BS 5345:1976.

(b) Where an insulated return circuit is used, there should not be more than 300 milliamp leakage between either polarity circuit and the vehicle chassis.

(c) A master switch to Zone 2 requirements, as defined in BS 5345: 1976 to enable all electrical circuits to be isolated (including open circuiting of the alternator field windings), should be placed as near as possible to the battery. This should not prevent intrinsically safe circuits or flameproof circuits to Zone 1 requirements, as defined in BS 5345: 1976 from being taken from the battery side of the master switch. The master switch control should be readily accessible to persons outside the vehicle and its location should be indicated by a clearly visible notice. Means should be provided at all times to indicate visually when the master switch is in the "ON" or "OFF" position.

(d) All electrical equipment within the following areas should be suitable for the appropriate Zone (BS 5345) as indicated.

(i) Within an area between the ground and a point 300 mm above and on each side of any discharge opening - Zone 1.

(ii) Within an area between the ground and a point 1 m above and on each side of any discharge opening - Zone 2.

(iii) On the top of the tank - Zone 1.

The above requirements need not be met where all electrical equipment within these areas is isolated during loading and unloading operations by means of the master switch referred to at (c) above.

Circuit Protection

7 The following steps should also be taken to ensure protection of the electrical circuits -

- (a) All circuits, with the exception of the main battery supply and the starter and alternator circuits, should be protected with fuses or circuit breakers in the feed side of each circuit.
- (b) All circuit protective devices, with the exception of any barrier device for a tachograph or other intrinsically safe device, should be mounted forward of the rear of the cab.
- (c) Exposed fuse wire or links should be avoided, but if used should be fitted within an enclosed unit.
- (d) The number of circuits connected to any protective device should not exceed four, and the rating of the device should be compatible with the smallest conductor in any of these circuits. Thermal circuit breakers can be safely designed to carry 100% of their rating continuously but this rating should be limited to a level which gives a temperature rise within the performance specification of the cable insulation.
- (e) Any fuse type circuit protective device should be designed to open circuit within 10 seconds when passing a current equal to 200% of its normal rating in accordance with BS 2950: 1958. For a thermal circuit breaker, the trip time at 200% of its normal rating should not exceed 30 seconds.

- (f) Grouping of circuits should be so arranged that the failure of any minor circuit does not render a major or obligatory circuit inoperative.

Static Electricity

8 Electrical continuity should be maintained between the tank and the carrying vehicle and between the chassis of the tractor and the chassis of the trailer in articulated vehicle. The electrical resistance should not exceed 10 ohms. The vehicle should be provided with a static electricity earthing connection for use during loading and unloading.

Rear-End Protection

9 The vehicle should be provided with a rear bumper to provide protection for the tank in the event of a rear end collision. The rear face of the bumper should be located at least 100mm to the rear of the tank shell or its fittings, other than an open rung ladder.

Vehicle Stability

10 The height of the centre of gravity of the load should not be greater than 95% of the distance between the outer walls of the supporting tyres measured to the outside of their contact with the ground.

Driver's Cab

11 Other than for vehicles used by Her Majesty's forces or visiting forces (as defined in the Visiting Forces Act 1952, as amended), there should be no opening in the cab roof of vehicles used to convey liquids with a flash point

less than 21°C. Where windows are provided at the back of the cab they should not be capable of being opened.

12 Where a cab heater, other than that operated from the vehicle's engine, is installed, it should be a totally enclosed combustion type complying with the following requirements.

(a) The combustion unit and its exhaust pipe should be located in such a position or be so shielded that any spillage or leakage of flammable liquid being conveyed cannot impinge on any heated surface of the system.

(b) The heater should be connected to the vehicle's electrical system in such a way that -

(i) the heater can only be switched on by the activation of a separate switch in the cab; and

(ii) the heater cannot be used when the engine is running.

(c) A notice should be installed adjacent to the switch at (b)(i) above which states -

"The heater must not be switched on at loading and unloading premises or during loading and unloading processes".

13 There should be a space of not less than 100mm between the rear of the cab and the foremost point of the carrying tank or any attachment to the tank, other than an open rung ladder and those connections between the cab and the tank which are necessary for the operation of the vehicle.

Tank Mounting

14 The tank (including its support and attachments) should be so fitted that if under the maximum permissible load it is subjected to an acceleration or deceleration of 2 g in the direction of travel, 1 g at right angles to the direction of travel, 1 g vertically upwards or 2 g vertically downwards, the maximum stress, or design load in the case of reinforced plastics tanks, in any part thereof will not exceed that specified in paragraph 19.

15 The carrying tank should be securely attached to the vehicle in accordance with the following conditions -

- (a) The materials used for the construction of all load carrying mountings attached to the tanks should be as set out in paragraph 18 or should have equal or superior mechanical properties.
- (b) Mounting structures should be designed to prevent excessive movement of the tank in relation to the chassis. This would not exclude the use of flexible mountings. They should take into account the loadings referred to in paragraph 14.
- (c) Where the mounting structures are designed as an integral attachment to the shell, each attachment should be designed to alleviate high stress conditions.
- (d) Relative movement between tank supports directly attached to the chassis and chassis should be prevented, for example, by the use of fitted bolts.

Test Pressure of Tank

16 This Code applies to non-pressure tanks which are only suitable for gravity or pump discharge. The tank and its compartments should be designed to withstand a test pressure of 0.32 bar gauge.

Vacuum Conditions

17 The tank may be subjected to a slight vacuum during its operation but this will be limited by the requirement for a vent valve at paragraph 40(b). The tank should be so designed that it is capable of withstanding the vacuum conditions in paragraph 40(b)

Tank Materials

18 The materials of tanks and pipework in contact with the contents should be chemically compatible with the contents, ie they should not contain substances liable to react with the contents in such a way as to affect their strength. The following are examples of materials suitable for the construction of tanks. Similar materials may be used with the agreement of the competent person referred to in Regulation 7(2)(b).

- | | |
|------------------|-----------------------------------|
| (a) Carbon Steel | BS 4360 - 1979 - 40B |
| | BS 4360 - 1979 - 43A |
| | BS 1501 - Part 1 - 1980 151 - 430 |
| | BS 1501 - Part 1 - 1980 154 - 400 |
| | BS 4360 - 1979 - 50B |

(b) Stainless Steel: BS 1449 - Part 2 1983 - All austenitic grades other than 284S16

BS 1501 - Part 3 1973 304S15

321S12

347S17

316S12

316S16

(c) Aluminium BS 4300/8 - 1969 5454
 BS 1470 - 1972 NS5, NS8
 AA 5454 - 1982

Aluminium Extrusions: BS 1474 - 1972 2014A

6082

(d) Reinforced Plastics

As the characteristics of reinforced plastics laminates may vary according to their structure, minimum values for tensile strength are prescribed in BS 4994 in terms of unit strength per type of laminate layer, from which the strength of a laminate can be established. The minimum ultimate tensile unit strength of the laminate for tanks of the following capacity should be:-

Up to and including 3,000 litres - 500 N/mm of compartment length

Over 3,000 litres - 550 N/mm of compartment length

The values given apply to laminates incorporating only E glass reinforcement complying with the requirements of

BS.3396: 1970, Part 3, BS.3496: 1973, BS.3749: 1974 or

BS.3691: 1969 and having a glass content by weight within the range 28% to 45% for chopped strand mat (C.S.M.) and 45% to 55% for woven roving (W.R.) cloth. Values for laminates including other types of reinforcement, other glass contents or sandwich construction should be at least equivalent to those quoted herein.

The tank should be cured such that the Barcol hardness is not less than 90% of the hardness value published by the resin manufacturer for the particular resin system. For polyester resins the residual styrene content should not exceed 2% by weight of the resin content of the sample (taken from a 'cut-out' or a sample layed-up and cured under the same circumstances as the main laminate).

Allowable Stress

19 The allowable stress in the material of the tank while under hydraulic test pressure, and in the tank mounting structures, supports, brackets and anchor bolts, at the most severely stressed points, under the worst combination of pressure and the loadings in paragraph 14, should not exceed three quarters of the yield or guaranteed proof stress (i.e. 1% proof stress for austenitic steels; 0.2% proof stress for other steels) for metallic fabrications. For reinforced plastics construction, under the same conditions, the allowable loadings of BS 4994 for design and test conditions, as appropriate, should not be exceeded.

Tank Material Thickness

20 The thickness of the tank shell should be not less than the appropriate value in Table 1. The thickness of the ends and compartment divisions should in no case be less than the minimum requirement for the shell. The minimum thickness for reinforced plastics construction does not include the thickness of any thermoplastics or resin lining system.

In the case of a reinforced plastics construction made up of an inner or series of inner tanks and an outer tank with an intervening space filled with an energy absorbing medium such as polyurethane foam, the minimum thickness is the total minimum thickness of both reinforced plastics layers. The thickness of the inner layer should be at least 35% of the total thickness.

21 Steel baffles should not be less than 2.5 mm thick.

Aluminium baffles should not be less than 3.0 mm thick.

Reinforced plastics baffles should be not less than 4.0mm thick.

Table 1 Minimum Shell Thickness

Capacity of Tank or Tank Compartment (litres)	Carbon Steel (mm)	Stainless Steel (mm)	Aluminium Alloy (mm)	Reinforced Plastics (hand lay up) (mm)	Reinforced Plastics (closed mould) (mm)
3000 or less	2.5	2.5	3.0	5.0	4.0
Over 3000 - 5000	2.5	2.5	4.0	6.0	5.0
Over 5000 - 7600	3.0	2.5	4.0	6.0	5.0
Over 7600	4.0	3.0	5.0	6.0	6.0

Tank Ends, Divisions, Baffles and Ring Stiffeners

22 All tanks should be constructed as follows.

(a) The distance between tank ends, divisions, or baffles should not exceed 2500mm.

(b) Flat bulkheads and baffles without reinforcement should not be used. Where dished divisions or baffles are used the depth of dish excluding the flange should not be less than 8% of the minor axis of the tank cross-section and in no case less than 100 mm unless adequate dish stiffeners are provided.

(c) Every baffle should have an area of at least 80% of the cross-sectional area of the tank.

- (d) Provision should be made in baffles for access for complete internal inspection of tank shell and fittings. The access should comply with the manhole requirements in paragraph 26.
- (e) Metallic Baffles or divisions should be continuously welded to the shell so as to alleviate high stress concentrations.
- (f) If spaces are formed between compartments or between baffles, divisions or internal backing plates welded or bonded directly to the tank shell or in lapped joints where product can collect, such spaces should have venting and drainage facilities.
- (g) Where longitudinal baffles are fitted, they should be fixed only to the transverse baffles or compartment divisions and not to the fixed ends of the tank.

Tank Linings

23 A protective lining may be applied internally providing provision is made to dissipate electrostatic charges adequately. The lining should be compatible with the product(s) to be conveyed in the tank.

Reinforced Plastics Tanks Electrical Conductivity

24 A metal component of not less than 0.04 m^2 per m^3 of product carried should be provided in each tank or compartment so that there is electrical continuity between the metal component and the earthing connection referred to in paragraph 8. Furthermore, no part of the product carried should be further than 2 m. from the earthed metal component.

The metal component may take the form of:-

- (a) a metal foot valve, pipe outlet or plate, situated in the base of the compartment, provided the total area in contact with the liquid is not less than that specified; or
- (b) a metallic grill of wire thickness not less than 1mm diameter formed to give a mesh area of not more than 4 cm^2 provided that the total area of the metal in contact with the liquid is not less than that specified.

In addition to the above, the reinforced plastics laminate which is in contact with the product should have a bulk resistivity of less than 10^8 ohm metres.

Where the tanker is of a sandwich construction, the reinforced plastics inner tanks containing the product should meet the above specification but the outer laminate which does not come into contact with the product should have a surface resistance of less than 10^{10} ohms.

Limits of Ullage

25 Each tank or tank compartment should be sized so that, when conveying the required payload, the tank or compartment has the necessary ullage (see Approved Code of Practice on the Operational Provisions of the Tanker Regulations - paragraphs 22-24).

Tank Access

26 Each tank or compartment of the tank should be constructed with a manhole to provided access to enable the tanker interior to be examined. The manhole should be not less than 410 mm long and 360 mm wide if rectangular or oval, or not less than 410 mm in diameter, if circular.

Valves and Ancillary Fittings

27 Tank valves, sealing caps and other fittings, including sealing joints, should not be manufactured from substances which are liable to react with, or be adversely affected by, the substance(s) being conveyed. All attachments to openings in the tank shell should be fitted with suitable sealing joints.

28 If the tank is designed to be open filled through a filling opening in the manhole cover assembly without fixed internal filling pipes:-

- (a) the manhole cover assembly should be securely attached to the tank;
- (b) openings in the manhole cover assembly should be fitted with seals of such material and so designed to effectively prevent escape of contents; and
- (c) the lid of the manhole cover assembly should be provided with means to close it securely.

29 If the tank is designed to be filled through a closed connection at the top of the tank, any such connection should be fitted with a suitable means for preventing dangerous differences in electrical potential arising inside the tank during filling, eg an internal pipe carried as near as possible to the bottom of the tank which should be fitted externally with a means to close it securely. When substances with a flashpoint of less than 21°C are conveyed any opening in the internal pipe should be covered with a gauze manufactured from wire not less than 300 micron diameter formed to give a mesh of not more than 500 micron diameter.

30 Any dip stick guide tube should be fitted externally with a means to close it securely. When substances with a flash point of less than 21°C are conveyed any opening in the internal pipe should be covered with gauze manufactured from wire not less than 300 micron diameter formed to give a mesh of not more than 500 micron diameter.

31 Each tank or compartment which has bottom draw-off or bottom filling connections should conform to the following requirements.

- (a) An internal stop valve, a secondary external closure valve and a sealing cap or blank flange should be fitted. Where the secondary external closure valve is remote from the internal stop valve the pipe between the valves should be designed to break when subjected to excessive strain at a point as close as practicable to the internal stop valve, leaving the internal stop valve intact. The tank should incorporate facilities for the drainage of the contents of each compartment via the internal stop valves and secondary external closure valves.

- (b) Bottom closed fill connections should be fitted with a suitable means for preventing dangerous differences in electrical potential arising inside the tank during filling, eg an internal deflector plate.
- (c) The setting (open/closed) of the internal stop valve should be capable of being verified visually.
- (d) Each outlet should be provided with a means to prevent unauthorised release of the contents of the tank. Suitable methods include:-
 - (i) a locking device to secure the operating mechanism of the outlet valve;
 - (ii) a locking device to secure the door of a strong compartment which contains the outlet valve and/or the outlet connection;
or
 - (iii) the termination of the outlet in a bolted and jointed blank flange secured by a minimum of 4 bolts.
- (e) Each tank inlet and outlet should be labelled with its compartment number and capacity.

32 All tank valves, fittings, pumps, pipework and ancillary fittings should be so sited or protected as to minimise the risk of damage and contents leakage in the event of the vehicle being involved in an accident.

33 Provision should be made to allow for and prevent damage due to expansion, contraction and vibration of all pipes.

34 Each discharge pipe outlet, when not in use, should be fitted with a means of effectively sealing the outlet.

35 Any discharge pump should be fitted with means to prevent excessive pressures developing in the discharge system.

36 The road clearance of any tank valve or ancillary fitting or protection device should be a minimum of 300 mm with the vehicle laden. This requirement is not applicable to tractor units.

37 Ullage gauges should not be used.

Pressure Relief Devices

38 Each tank or tank compartment should be fitted with pressure relief devices as outlined below. Any such device should communicate directly with the vapour space. No intervening shut-off valve should be fitted between the tank and any pressure relief device.

39 Pressure relief devices should be fitted to provide for normal and emergency venting as described in paragraphs 40-42 below. Such devices should be designed to prevent leakage of liquid, other than that due to initial surge, past the devices in the event of the vehicle overturning. This should not prevent the emergency venting device required in paragraph 42 from commencing to vent at the designed pressure setting when the tank is in any position, even when overturned.

40 Normal venting of a non-pressure tank is required to accommodate changes in atmospheric temperature and to permit the tank to 'breathe' under discharge conditions. Therefore each tank or compartment should be fitted with a safety valve (or valves) designed and constructed so that each valve:-

- (a) opens automatically under an internal gauge pressure of not more than 0.12 bar and which has an effective venting area of not less than 2.5 cm^2 ;
- (b) opens automatically when the external air pressure exceeds the pressure inside the tank by not more than 4.5 millibar and has an effective venting area such that the external to internal pressure differential does not exceed 70 millibar at the designed maximum discharge rate of the tank; and
- (c) should be fitted with a device forming an efficient flame trap constructed from gauze manufactured from wire not less than 300 micron diameter formed to give a mesh of not more than 500 micron diameter.

41 To meet the requirements of normal venting during closed filling through top or bottom connections, vents additional to those contained in paragraph 40(a) will be necessary. The emergency devices required by paragraph 42 below may be used to meet this requirement. Unless effective overfill protection is provided, the devices should have sufficient liquid venting capacity to prevent the tank internal pressure exceeding 0.32 bar gauge.

42 Emergency venting is that venting normally required under fire engulfment conditions. In addition to the normal venting requirements every tank or tank compartment should be provided with a venting device (or devices) designed -

- (a) to operate automatically at an internal gauge pressure of not less than 0.21 bar; and
- (b) to open sufficient at an internal gauge pressure not exceeding 0.35 bar so as to provide a free air flow of not less than 240 m^3 per hour for every m^2 of exposed external surface area of the tank or compartment.

At least 50% of the total venting capacity required by (a) and (b) above should be provided by spring loaded pressure actuated devices. The additional capacity can be provided by fusible venting devices so located as not to be in contact with the liquid being carried in the tank under normal operating conditions. The fusible venting devices should be actuated by elements which operate at a temperature not exceeding 120°C . The combined venting capacity of these devices should be rated such as to limit the pressure within the tank to not more than 0.35 bar gauge.

Tank Overturn Protection

43 All tank top fittings should be protected from damage in the event of the overturning of the vehicle. This may be achieved by enclosing them within the contour of the shell, or by a rigid coaming welded to the tank shell or adequately bonded thereto in the case of reinforced plastics construction.

The area enclosed by such protection should be adequately drained directly to the ground. Any drain tubes should not be less than 38 mm bore. The coamings, where of one-piece construction, should be provided with plugs or cut-outs to enable the section to be gas freed, while still retaining adequate strength to act as overturn protection.

APPROVED CODE OF PRACTICE

Design and construction of road tankers
used to convey carbon disulphide

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PREFACE

This Code of Practice has been prepared by Courtaulds PLC, as the manufacturers and major users of carbon disulphide in the UK, in conjunction with the Health and Safety Executive. There has been joint discussion between representatives of the Confederation of British Industry, the Trades Union Congress, the Local Authorities, independent experts and the Health and Safety Executive on the contents of the Code under the auspices of the Health and Safety Commission's Advisory Committee on Dangerous Substances.

The Code has been approved by the Health and Safety Commission with the consent of the Secretary of State for Transport, under Section 16(1) of the Health and Safety at Work etc. Act 1974 (the "HSW Act") for the purposes of providing practical guidance with respect to the provisions of Regulation 6(1) of the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 (the "Tanker Regulations") (SI 1981 No. 1059). Any reference in this Code to another document does not imply approval of that document by the Health and Safety Commission under Section 16(1) of the HSW Act, except to the extent necessary to give practical effect to this Code.

Although failure to comply with any provision of this Code is not in itself an offence, that failure may be used in criminal proceedings as evidence that a person has contravened the regulation to which the provision relates. In such a case, however, it will be open to that person to satisfy the court that he has complied with the regulation in some other way.

Words and expressions which are defined in the HSW Act and the Tanker Regulations have the same meaning in this Code unless the context requires otherwise.

Coincident with the coming into force of this Code, Regulation 6(2) and Schedule 2 of the Tanker Regulations are revoked by the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) (Amendment) Regulations 198 . The guidance given in this Code now replaces the specific requirements for the design and construction of road tankers used for the conveyance of carbon disulphide which were detailed in Part II of Schedule 2 to the Tanker Regulations.

Because road tankers used for the conveyance of carbon disulphide are discharged under nitrogen or water pressure, they are pressure vessels as defined in Regulation 7(1).

The Code lays down minimum standards and does not take account of any special circumstances such as the use of vehicles over rough terrain. Such factors would have to be taken into account in deciding whether vehicles or tanks comply with the requirements of Regulation 6(1).

Unless the context requires otherwise, wherever "fittings" are referred to in the Code they should be interpreted as those items which are in contact with carbon disulphide or are used for filling, discharging or pressure relief of the tank, and which, if damaged, would be likely to cause a leakage of carbon disulphide.

The Code is intended to give practical guidance on the design and construction of road tankers and applies only to rigid vehicles, tractors or semi-trailers constructed after the date of coming into force of the Code. It does not apply to tank containers nor does it cover inspection and testing of the carrying tank and its fittings which normally takes place during or

immediately following construction. The requirements for such inspection and testing are provided in Regulation 7, and practical guidance is given in the Approved Code of Practice on the Examination, Testing and Certification of the Carrying Tanks of Road Tankers and of Tank Containers used for the Conveyance of Dangerous Substances (COP?).

The duty to comply with Regulation 6(1) is placed upon the operators of road tankers. "Operator" is defined in Regulation 5. The main purpose of this Code is to provide standards which an operator can present to a manufacturer when he wishes to order a new vehicle or carrying tank for a road tanker.

The standards laid down in the Code are minimum standards which an operator would have to relate to the intended purpose of the vehicles and tanks he was ordering. This code is not a detailed design code for manufacturers. Section 6 of the HSW Act lays a separate duty on any person who designs, manufactures, imports or supplies any article for use at work to ensure, so far as is reasonably practicable, that the article is so designed and constructed as to be safe and without risks to health when properly used.

The requirements laid down in the Tanker Regulations and in this Code for vehicles and tanks conveying carbon disulphide are in addition to any requirements imposed by the Road Traffic Act 1972 and associated legislation. Particular attention should be paid to the requirements of the Motor Vehicles (Construction and Use) Regulations 1978 and amendments thereto.

Other guidance on the requirements of the Regulations and on the provision of safe means of access to tank tops is contained in the following documents:-

Approved Code of Practice on the Classification of Dangerous Substances for Conveyance in Road Tankers and Tank Containers (CoP 5).

Approved Code of Practice on the Operational Provisions of the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981 (COP 11).

Guide to the Dangerous Substances (Conveyance by Road in Road Tankers and Tank Containers) Regulations 1981. Health and Safety Series Booklet HS(R)13.

Access to Road Tankers. Health and Safety Executive Guidance Note GS 26.

REGULATION 6(1)

For ease of reference, Regulation 6(1) is reproduced below:

- (1) An operator shall not use any vehicle or any tank container for the conveyance by road of a dangerous substance unless -
 - (a) it is properly designed, of adequate strength and of good construction from sound and suitable material;
 - (b) it is suitable for the purpose for which it is being used having regard to -
 - (i) the nature and circumstances of the journey being undertaken; and
 - (ii) the characteristic properties and quantity of the dangerous substance and of all other substances being conveyed (including any which are not in themselves dangerous);
 - (c) the carrying tank of the road tanker or, as the case may be, the tank container and any fittings attached thereto -
 - (i) are designed, constructed and maintained so as to prevent any of the contents escaping, except that this requirement shall not prevent the fitting of a suitable safety device; and

(ii) in so far as they are likely to come into contact with the substance, are made of materials which are neither liable to be adversely affected by the substance nor liable in conjunction with it to form any other dangerous substance which would significantly increase the risk to the health and safety of any person.

APPROVED CODE OF PRACTICE

The Engine

1. The engine should be of the compression ignition type. An external accessible means should be provided to stop the engine in an emergency. This engine stop should be indicated by a clearly visible notice.

Air Induction System

2. The air induction system should be located in such a position as to minimise the possibility of induction of carbon disulphide vapour from any spillage or from any release from a safety relief device.

Exhaust System

3. The exhaust system, including any turbo charger, should be located in such a position or be so shielded that any spillage or leakage of carbon disulphide cannot impinge on the heated surface of the system. A vertical exhaust may be used provided there is an effective method of preventing ingress of carbon disulphide.

Fuel System

4. The fuel tank should not be located directly above the engine or its exhaust system.

Electrical System

5. The electrical system should be designed, installed and adequately protected to minimise mechanical damage and the risk of electrical fires. In particular the system should conform to the following requirements.

- (a) The nominal circuit voltage on any circuit on the vehicle should not exceed 24 volts.
- (b) Modifications or repairs to electrical circuits or equipment should be in accordance with manufacturer's instructions or be to recognised manufacturer's or equivalent standards.
- (c) Batteries should be effectively protected against spillage of carbon disulphide, and be fitted with an insulated cover against inadvertent contact by objects which could cause a spark.
- (d) All cables should be located and secured on the vehicle so that they are protected against mechanical damage and heat.
- (e) Behind the rear of the driver's cab -
 - (i) all cables should have copper conductors (except for the heavy duty cable from the battery to the starter motor which may be in aluminium provided compression terminations are used, and should be insulated and further covered in accordance with the requirements of BS 6862:1971 or equivalent standard. They should be conservatively rated to avoid undue temperature rise in service.

- (ii) no screw-in or capless bulbs should be used;
 - (iii) junction boxes, connectors and all electrical equipment should be adequately protected and shielded as far as practicable from the ingress of moisture or carbon disulphide under normal conditions of use; and
 - (iv) switches should be suitable for use in Zone 2 areas as defined in BS 5345:1976.
- (f) Where an insulated return circuit is used, there should not be more than 300 milliamp leakage between either polarity circuit and the vehicle chassis.
- (g) A master switch to Zone 2 requirements, as defined in BS 5345: 1976, to enable all electrical circuits to be isolated (including open circuiting of the alternator field windings), should be placed as near as possible to the battery. This should not prevent intrinsically safe circuits or flameproof circuits to Zone 1 requirements, as defined in BS 5345:1976, from being taken from the battery side of the master switch. The master switch control should be readily accessible to persons outside the vehicle and its location should be indicated by a clearly visible notice. Means should be provided at all times to indicate visually when the master switch is in the "ON" or "OFF" positions.

- (h) All electrical equipment fitted to the top of the tank should be suitable for use in a Zone 1 area. This requirement need not be met where all electrical equipment within this area is isolated during loading or unloading operations by means of the master switch referred to at (g) above.

Circuit Protection

6 The following steps should also be taken to ensure protection of the electrical circuits -

- (a) All circuits, with the exception of the main battery supply and the starter and alternator circuits, should be protected with fuses or circuit breakers in the feed side of each circuit.
- (b) All circuit protective devices, with the exception of any barrier device for a tachograph or other intrinsically safe device, should be mounted forward of the rear of the cab.
- (c) Fuses should be of the cartridge type and should be fitted within a sealed unit.
- (d) The number of circuits connected to any protective device should not exceed four, and the rating of the device should be compatible with the smallest conductor in any of these circuits. Thermal circuit breakers can be safely designed to carry 100% of their rating continuously but this rating should be limited to a level which gives a temperature rise under any fault condition within the performance specification of the cable insulation.

- (e) Any fuse type circuit protective device should be designed to open circuit within 10 seconds when passing a current equal to 200% of its normal rating in accordance with BS 2950:1958 or equivalent standard. For a thermal circuit breaker, the trip time at 200% of its normal rating should not exceed 30 seconds.
- (f) Grouping of circuits should be so arranged that the failure of any minor circuit should not render a major or obligatory circuit inoperative.

Static Electricity

7. Electrical continuity should be maintained between the tank and the carrying vehicle and between the chassis of the tractor and the chassis of semi-trailer in an articulated vehicle. The electrical resistance should not exceed 10 ohms. The vehicle should be provided with a static electricity earthing connection for use during loading and unloading.

Rear-End Protection

8. The vehicle should be provided with a rear bumper to provide protection for the tank in the event of a rear-end collision. The rear face of the bumper should be located at least 100mm to the rear of the tank shell or its fittings, other than an open rung ladder.

Vehicle Stability

9. The overall width of the ground-level bearing surface, measured as the distance between the outer points of contact with the ground of tyres on the same axle, should be at least 90% of the height of the centre of gravity of the laden vehicle.

Driver's Cab

10. There should be no opening in the cab roof. Where windows are provided at the back of the cab they should not be capable of being opened.

11. Where a cab heater, other than that operated from the vehicle's engine, is installed, it should be a totally enclosed combustion type complying with the following requirements.

(a) The combustion unit and its exhaust pipe should be located in such a position or be so shielded that any spillage or leakage of flammable liquid being conveyed cannot impinge on any heated surface of the system.

(b) The heater should be connected to the vehicle's electrical system in such a way that -

(i) the heater can only be switched on by the activation of a separate switch in the cab; and

(ii) the heater cannot be used when the engine is running.

(c) A notice should be installed adjacent to the switch at (b)(i) above which states -

"The heater must not be switched on at loading and unloading premises or during loading and unloading processes".

12. There should be a space of not less than 100mm between the rear of the cab and the foremost point of the carrying tank or any attachment to the tank, other than an open rung ladder and those connections between the cab and the tank which are necessary for the operation of the vehicle.

Tank Mounting

13. The tank (including its support and attachments) should be fitted to the vehicle so that, if under the maximum permissible load it is subjected to an acceleration or deceleration of 2g in the direction of travel, 1g at right angles to the direction of travel, 1g vertically upwards or 2g vertically downwards, the maximum stress in any part thereof will not exceed that specified in paragraph 18.

Tank Mounting Structures, Supports, Brackets and Anchor Bolts

14. The carrying tank of a road tanker should be securely attached to the vehicle in accordance with the following conditions -

- (a) the materials used for the construction of all load carrying mountings attached to the tank should be compatible with tank shell material and be of weldable quality.
- (b) Mounting structures should be designed to prevent excessive movement of the tank in relation to the chassis in the case of a road tanker but this would not exclude the use of flexible mountings. The mounting structures should take into account the loadings referred to in paragraph 13.
- (c) Where the mounting structures are designed as an integral attachment to the tank shell, each attachment should be designed to alleviate high stress conditions.
- (d) Relative movement between tank supports directly attached to the chassis and the chassis of a road tanker should be prevented, for example, by the use of fitted bolts.

Tank Design

15. The shell of the tank, including all openings and their closures, should be designed and constructed to BS 5500:1982, or other recognised pressure vessel code, for a design pressure of 3 bar (gauge), except that the minimum thickness of the tank should not be less than 6mm if made of carbon steel or 5mm if of stainless steel. Each tank or tank compartment should be so designed that the ullage space is not less than 6% of the nominal capacity. The design should ensure that there is no risk of deformation as a result of negative internal pressure, i.e. the tank should be designed to withstand an external pressure of 0.41 bar gauge.

Test Pressure

16. The test pressure for the complete tank should be 4 bar (gauge). The test pressure for individual compartments should be 2 bar (gauge).

Tank Materials

17. The tank and any divisions or baffles should be made of a suitable grade of carbon steel or stainless steel. The following are examples of materials which are suitable. Similar materials may be used with the agreement of the competent person referred to in Regulation 7(2)(b).

(a) Carbon steel BS 4360-1979-40B

43A

50B

BS 1501-Part 1-1980 151-430

154-400

(b) Stainless steel BS 1449-Part 2-1983 - All austenitic grades other
than 284S 16

BS 1501-Part 3 1973 304S 15

321S 12

347S 17

316S 12

316S 16

Allowable Stress

18. The stress in the material of the tank, while under hydraulic test pressure, and in the tank mounting structures, supports, brackets and anchor bolts, at the most severely stressed points, under the worst combination of pressure and the loadings in paragraph 12, should not exceed three quarters of the yield or guaranteed proof stress (i.e. 1% proof stress for austenitic steels, or 0.2% proof stress for other steels).

Tank Divisions, Baffles and Ring Stiffeners

19. The following requirements should be complied with:

- (a) Any divisions should be designed to enable each compartment of the tank to meet a test pressure of 2.25 bar gauge.
- (b) Flat baffles without reinforcement should not be used. Where dished baffles are used, the depth of dish excluding the flange should not be less than 8% of the minor axis of the tank cross-section and in no case less than 2.5 mm thick and should have an area of at least 80% of the cross-sectional area of the tank. The design of any baffle should allow the complete filling and emptying of the tank.
- (c) Provision should be made in baffles for access for complete internal inspection of the tank shell and fittings. The access should comply with the manhole requirements in paragraph 21.

(d) Where longitudinal baffles are fitted, they should be fixed only to the transverse baffles or compartment divisions and not be fixed to the ends of the tank.

(e) If spaces are formed between compartments or between baffles, divisions or internal backing plates welded directly to the tank shell where product can collect, such spaces should have venting and drainage facilities.

Protective Coatings

20. A protective lining may be applied internally providing provision is made to dissipate electrostatic charges adequately. The lining should be compatible with carbon disulphide. If a tank is painted externally, a light colour or solar-heat reflecting paint should be chosen. Aluminium paint should not be used.

Tank Access

21. Each tank or compartment of the tank should be constructed with a manhole to provide access to enable the interior to be examined. The manhole should be not less than 410mm long and 360mm wide if rectangular or oval, not less than 410mm in diameter if circular.

Valves and Ancillary Fittings

22. Tank valves, sealing caps and other fittings including sealing joints should not be manufactured from substances which are liable to react with or

be adversely affected by carbon disulphide. All attachments to openings in the tank shell should be fitted with suitable sealing joints.

23. All openings of tanks should be above the surface level of the liquid and no pipes or pipe connections should pass through the walls of the tank below this surface level. The system of discharge for the tank should be by inert gas pressure or water displacement. Valves should be protected with lockable covers. Openings, other than those fitted with valves, should be fitted with leak proof closures. Any ventilating opening should be fitted with a flame arrester consisting of a gauze manufactured from wire not less than 300 micron diameter formed to give a mesh of not more than 500 micron diameter.

24. Filling and discharge pipes should reach, as nearly as possible, the bottom of the tank, and should be fitted with a liquid seal. Dipping pipes should also reach as near as possible the bottom of the tank. Openings other than the top opening of a dipping pipe should be fitted with a flame arrester, constructed in accordance with paragraph 23.

Safety relief devices

25. Each tank or tank compartment should be fitted with pressure relief devices to provide for normal and emergency venting. Such devices should be designed to prevent the leakage of liquid, other than that due to initial surge, past the devices in the event of the vehicle overturning.

Normal venting should be achieved with a relief valve designed to operate at an internal gauge pressure of not greater than 1.5 bar.

26. Emergency venting is that venting normally required under fire engulfment conditions. In addition to the normal venting arrangements, every tank or tank compartment should be provided with a venting device, or devices, designed to operate at an internal gauge pressure not greater than 1.5 bar. The devices should open sufficiently at an internal gauge pressure no greater than 2 bar so as to provide a free air flow of not less than 300 m^3 per hour for every m^2 of exposed external surface area of the tank or compartment.

27. All pressure relief devices should communicate directly with the vapour space. No shut-off valves should be fitted between the tank and any pressure relief device.

Tank Overturn Protection

28. All tank top fittings, through which liquid could escape if they were damaged, should be protected from damage in the event of overturning of the vehicle. This may be achieved by enclosing them within the contour of the shell, or by a rigid coaming welded to the tank shell. The area enclosed by such protection should be adequately drained directly to the ground. Any drain tubes should not be less than 38 mm bore. The coamings, where one-piece, should be provided with plugs or cut-outs to enable the section to be gas freed, while still retaining adequate strength to act as overturn protection.